PALYNOLOGIC CORRELATION OF THE DORSET 'WEALDEN'

by N. F. HUGHES *and* C. A. CROXTON

ABSTRACT. Using the *Cicatricosisporites* group of palynomorphs, events raised from ten selected samples from the 'Wealden' of Worbarrow Bay, Dorset, are bracket-correlated with events of similar nature from the Warlingham Borehole, Surrey. Although sedimentation rates appear to have differed, deposition at Worbarrow seems to have continued throughout much of Berriasian to Aptian time as at Warlingham. The constituent data of the events comprised graded comparison records with the use of twelve new biorecords and some of those published by Hughes and Moody-Stuart (1969).

IN this paper we attempt to correlate by means of a selection of palynologic data, a section of about 1400 ft (425 m) of 'Wealden' strata exposed in the cliffs of Worbarrow Bay, Dorset. These beds overlie conformably some slightly dubious 'Upper Purbeck' beds north of Worbarrow Tout (Arkell 1947, and earlier authors) presumably of Berriasian age; they are overlain more or less conformably by 'Lower Greensand', with marine bivalves, which is presumably of Aptian age. These 'Wealden' strata may therefore be of any age from Early Berriasian to Late Aptian.

The attempted correlations are with the Wealden section of the Warlingham Borehole, Surrey, which is itself not yet firmly correlated with an international scale. The correlations are therefore not scale-dated as it would be premature to do this; it should, however, be possible to date Worbarrow automatically as soon as dates for parts of the Warlingham reference are agreed.

The appropriate rock samples and preparations have been deposited in the Sedgwick Museum, Cambridge.

Method. The method is explained in Hughes and Moody-Stuart (1969, pp. 86–87) and correlation is based on palynologic events raised from rock samples, in this case restricted to palynomorphs of the *Cicatricosisporites* group. The events are composed of graded comparison records (Hughes and Moody-Stuart 1967), based on taxa described as biorecords which in this case all come from Warlingham or Worbarrow rocks. Some previously described events and biorecords are taken from Hughes and Moody-Stuart (1969); the numerous new events and their constituent comparison records, plus twelve new biorecords, are presented systematically in a condensed tabular form. All these taxa are fully employed in the stratigraphic correlation; those not so required are omitted from the paper.

The handling of taxa is as described in Hughes (1971). No comparison is made with published Linnéan taxa as there is no stratigraphic purpose in doing so. Comparison records and biorecords may be reassembled subsequently into taxa under the Rules of Botanical Nomenclature (Stafleu *et al.* 1972) if required for some gross palaeoecologic synthesis.

Notation. Each biorecord bears a unique number which may be quoted with author initials and date if referred to outside the paper. The accompanying letter and number in italics is the observer's working identifier but is subsequently a non-search item.

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Each event is numbered in a similar way with the working sample (field) number in italics as a non-search item; several events of different taxal origin may be raised from one sample. Comparison records may be uniquely referred to either as 105 event *W128* cf. 6 *B5*, or as 105 event cf. 6 CICATR.

SYSTEMATIC DESCRIPTIONS OF BIORECORDS

Description common to all biorecords below. All trilete miospores; amb shape, equatorial shape, general distribution of muri, and mural profile may be taken from photographs. Measurements and other data are given on Tables 1 and 2, diagrammatic mural profiles to scale on text-fig. 1. Lips are simple, low, membranous unless otherwise stated. The ratio of radial to interradial exine thickness is given on Table 2, and no further reference is made to it in descriptions. On Table 2 measurements of exine include the murus in spores of negative sculpture, and exclude it in those of positive sculpture unless otherwise stated.

No comment is made under preservation concerning the frequent folding of thin-walled spores.

For preparation details see the appropriate event preparation Table 5, and for sample sediment details see Appendix.

17 CICATR *B20*

Plate 66; text-fig. 1

Description. Laesura may be sinuous. Proximal face sometimes shows a small smooth triangle or reduced muri (figs. 1, 3, 5). Proximal muri: three interradial sets of approximately 4. Polar view: 0–4 muri (in profile) cross radial margin (figs. 1, 4). Distally three sets of 4–12 muri form an asymmetrical pattern (fig. 9).

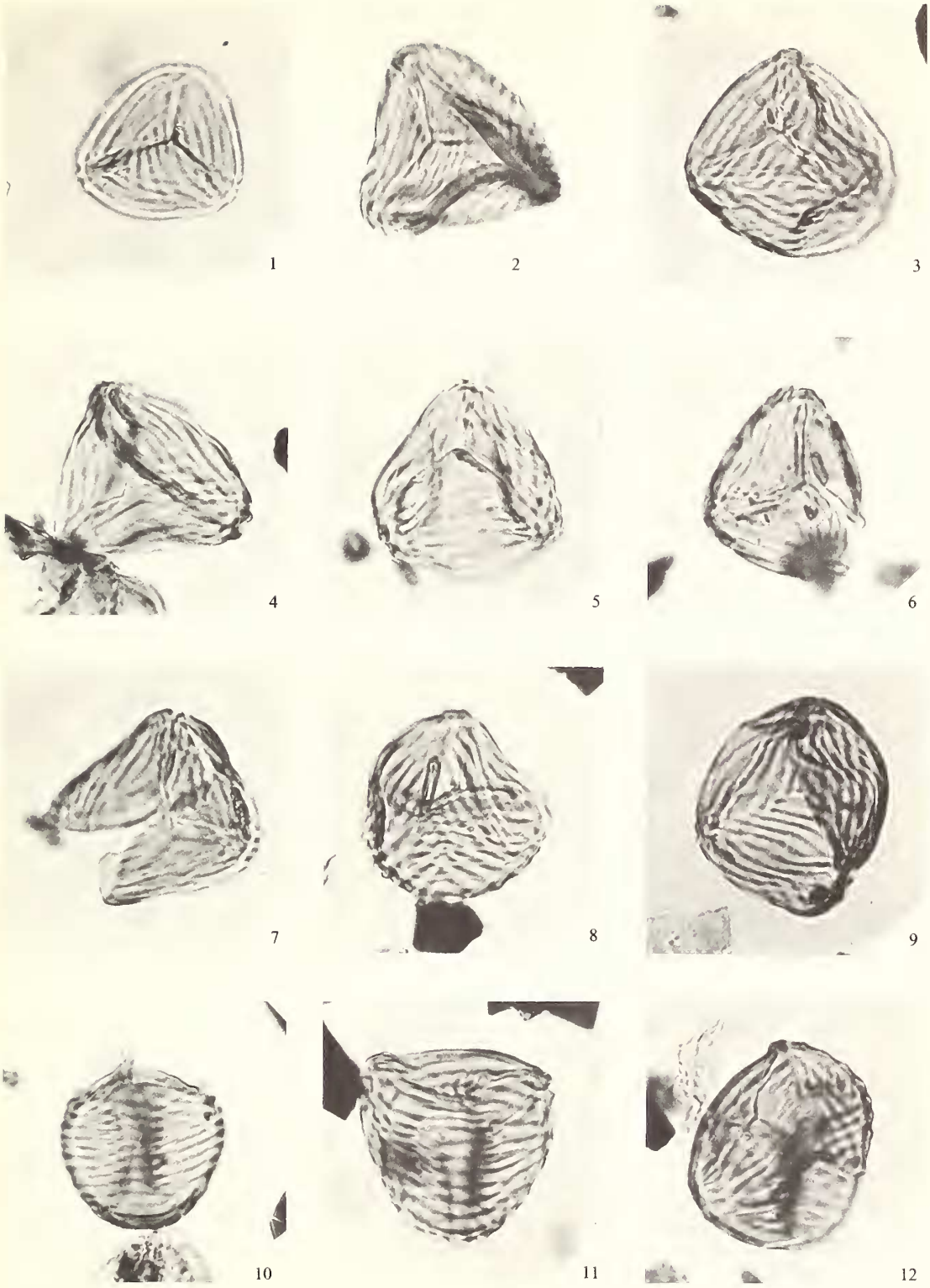
Preservation. 21% torn, often radially (figs. 6, 7).

Local distinction. 25 CICATR *B21* is larger and has more and narrower muri which are more closely spaced and have the characteristic 'swirling' pattern. 28 CICATR *DG* is larger with a thicker exine and negative sculpture.

EXPLANATION OF PLATE 66

Magnification, × 1000.

Figs. 1–12. Biorecord 17 CICATR *B20*, Slide KO18/7. 1, Proximal aspect; OR 28·7 117·8. 2, Distal aspect, low focus; OR 29·1 117·9. 3, Proximal aspect; OR 35·0 125·3. 4, Proximal aspect; OR 49·7 110·0. 5, Proximal aspect; OR 54·4 118·0. 6, Distal aspect, low focus; OR 37·4 110·6. 7, Distal aspect, low focus; OR 53·4 123·6. 8, Oblique aspect; OR 30·0 121·3. 9, Proximal aspect, low focus; OR 41·1 127·3. 10, Equatorial aspect; OR 35·0 119·0. 11, Equatorial aspect; OR 38·3 116·4. 12, Oblique aspect; OR 39·6 126·4.



HUGHES and CROXTON, biorecord 17 CICATR *B20*

TABLE 1. Sample, preparation, and diameter information for twelve biorecords.

CICATR Biorecord	Record Sample	Preparations	Diameter 100 specs. µm		Factors possibly influencing measurem'ts					
					Aspect %			Fern spore size index		
			Limits&Mean	σ	Pol.	Equ.	Obl.	<30 µm	30-50 µm	>50 µm
17. B20	WM 1655	K018/2,3,5,6,7	(22) 31·4 (44)	4·5	54	22	24	13	67	20
18. C3	WM 1749/8	V411/6,7,8,9	(30) 43·0 (61)	5·8	84	10	6	26	47	27
19. A6	WM 1681/6	V500/4,5,6,7	(27) 43·9 (63)	6·6	45	30	25	10	61	29
20. DD	WM 1415/3	V963/4	(39) 60·8 (92)	10·6	58	23	19	18	51	31
21. C4	WM 1415/3	V963/2-4. W103/1-3	(32) 45·9 (58)	5·3	77	18	5	18	51	31
22. DB	WM 1415/3	V963/1-4. W103/1-3 J035/3	(36) 59·0 (80)	10·5	72	19	9	18	51	31
23. DCE	WM 1415/3	V963/2-4. W103/1-3	(47) 70·1 (95)	10·4	75	13	12	18	51	31
24. C5	W 111	W190/1,2,3,4,5,6,7	(28) 43·1 (58)	6·3	73	21	6	29	61	10
25. B21	W 111	W190/1,2,3,4,5,6	(25) 38·4 (55)	7·1	49	34	17	29	61	10
26. A5T	W 9	W197/4,5,6	(31) 40·5 (55)	5·3	56	26	18	16	63	21
27. C6	W 14	V198/1-4. W262/1,3	(28) 42·1 (63)	6·2	54	39	7	19	43	38
28. DG	WM 1217/6	W058/1,2,3,8,7	(28) 37·2 (50)	4·6	66	22	12	23	51	26

18 CICATR *C3*

Plate 67; text-fig. 1

Description. Width of one lumen (0·8) 1·7 µm (4·5) (86). Proximal muri: three interradial sets of 1 or 2. Distal mural pattern either three sets of 2 (occasionally 3) muri forming a central tri-radiate lumen (figs. 4, 6) or a set of sub-parallel muri (fig. 7). Radial equatorial features are extensions of the coalesced outer muri from adjacent interradial sets; ratio length/width at half-length: (0·6) 1·2 (2·7) (82); some are parallel-sided and others cone-shaped. These features may not extend beyond the periphery of the amb (fig. 6).

Preservation. Characteristically split immediately adjacent to the radial equatorial feature. Corrosion of muri takes the form of cross striations (fig. 9).

Local distinction. 7 CICATR *C1* has narrower and more numerous muri, a thinner exine, and positive sculpture. 20 CICATR *DD* is larger and has a radial lumen. 27 CICATR *C6* has narrower muri with a different mural profile and variable radial equatorial extensions.

EXPLANATION OF PLATE 67

Magnification of figs. 1–9, ×1000; fig. 10, ×2000.

Figs. 1–10. Biorecord 18 CICATR *C3*. 1, Proximal aspect; V411/6, OR 56·5 117·0. 2, Proximal aspect; V411/6, OR 50·0 119·5. 3, 4, Distal aspect, low and high focus; V411/6, OR 35·0 121·0. 5, Proximal aspect; V411/7, OR 28·8 123·5. 6, Distal aspect, low focus; V411/6, OR 25·0 124·0. 7, Distal aspect; V411/8, OR 26·5 126·0. 8, Equatorial aspect; V411/7, OR 43·1 109·9. 9, Distal aspect; V411/8, OR 24·7 119·9. 10, Part of oblique aspect, showing mural profile; V411/7, OR 25·3 129·4.

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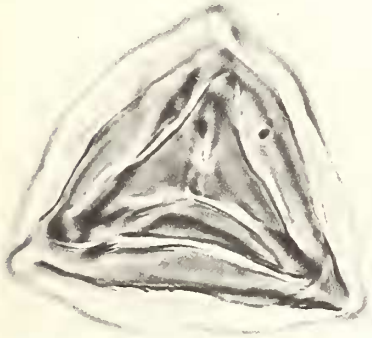

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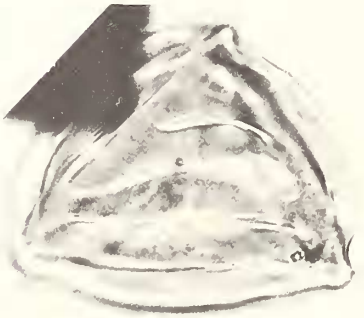

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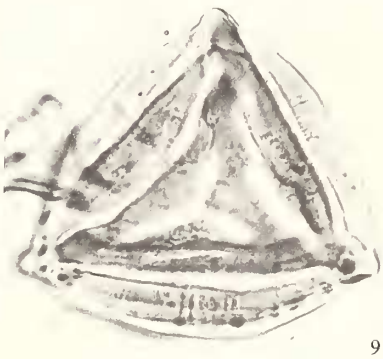

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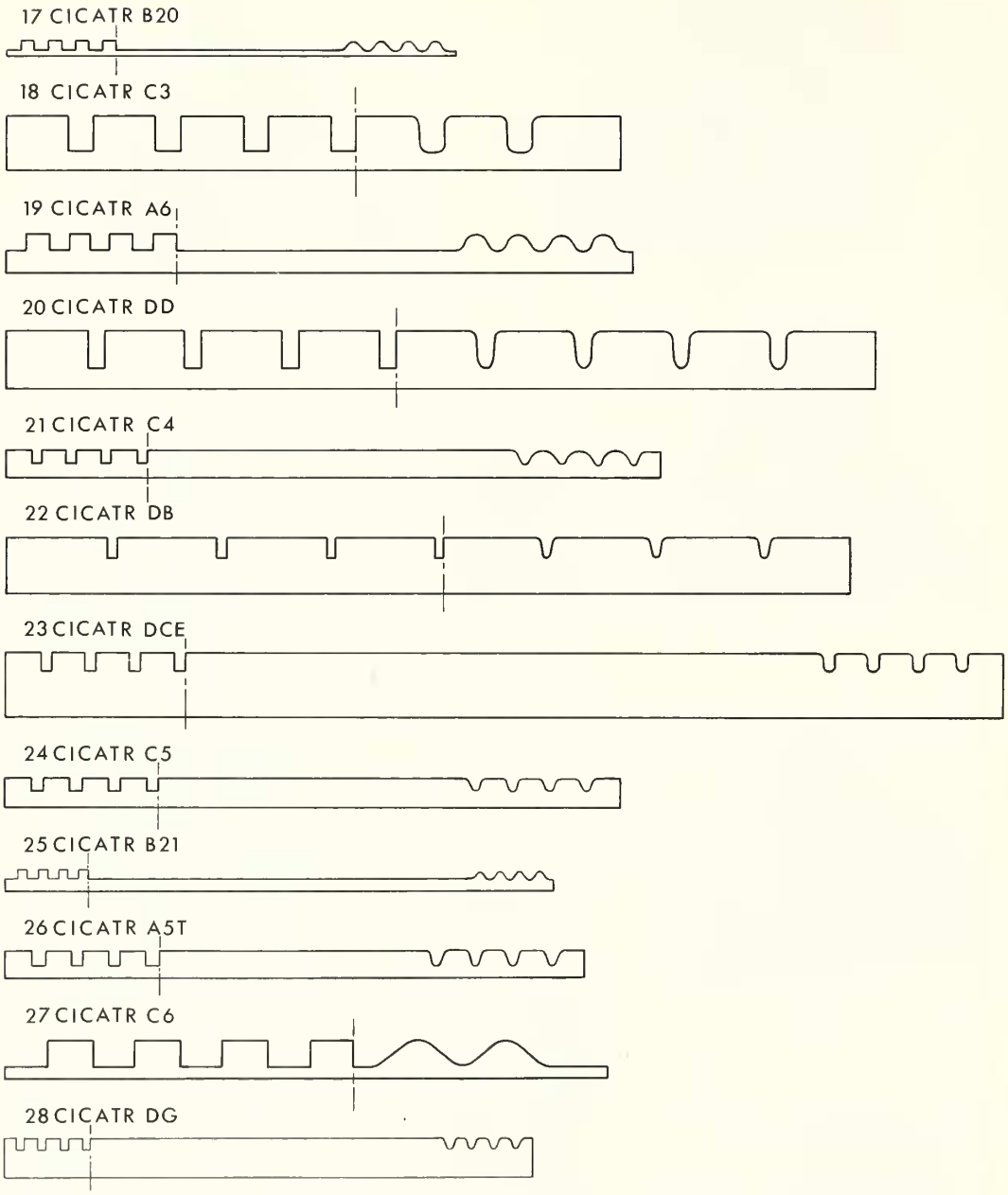
HUGHES and CROXTON, biorecord 18 CICATR *C3*



TEXT-FIG. 1. Mural profile diagrams of twelve biorecords, all to same scale. Left, four muri and lumina constructed from measurements made on spores, ×2000. Right, some sketched profiles.

TABLE 2. Exine and sculpture measurements for twelve biorecords. Certain measurements are omitted from the table when they are believed to lack significance, e.g. for four adjacent muri when the mean would exceed the spore radius; other comments in text.

CICATR Biorecord	Exine μm						Laesura	Sculpture μm								
	Interradial		Radial or Equatorial Extens.		Ratio Radial/ Interradial		Long or Short	+ve or −ve	Width of muri		4 adjacent muri and lumina			Height of muri		
	Limits & Mean	No.	Limits & Mean	No.	Limits & Mean	No.			Limits & Mean	No.	Limits & Mean	σ	No.	Limits & Mean	No.	
17. B20	(0·6) 1·0 (2·0) incM	58	(0·6) 1·5 (2·5) incM	49	(1·0) 1·9 (2·0)	48	Long	+	(0·5) 0·9 (1·5)	95	(4·8) 7·6 (10·0)	1·0	93	(0·4) 0·7 (1·3)	62	
18. C3	(1·5) 3·9 (5·5)	82	(2·5) 5·6 (8·0)	82	– – –	–	Long	–	(2·0) 4·4 (6·5)	97	– – –	–	–	– 2·5 –	1	
19. A6	(1·0) 1·5 (2·0) exM	41	(1·5) 2·3 (3·5) exM	41	(1·0) 1·5 (2·2)	41	Long	+/−	(1·0) 1·6 (2·7)	100	(7·0) 11·9 (20·0)	2·1	98	(0·7) 1·2 (2·0)	50	
20. DD	(2·0) 4·1 (6·0)	68	(3·0) 5·6 (9·0)	54	(1·0) 1·4 (2·7)	51	Long	–	(3·0) 5·6 (9·0)	100	(16·0) 27·1 (40·0)	5·0	58	(1·5) 2·6 (3·5)	19	
21. C4	(1·0) 1·9 (3·0)	71	(2·0) 4·3 (6·5)	77	(1·3) 2·3 (4·3)	71	Long	–	(1·0) 1·8 (3·0)	100	(7·0) 9·9 (13·0)	1·1	79	– 1·0 –	2	
22. DB	(2·0) 4·0 (8·0)	71	(3·0) 6·0 (12·0)	71	(1·0) 1·5 (3·3)	71	Short	–	(4·0) 7·0 (11·0)	100	(20·0) 30·5 (43·0)	5·6	55	(1·0) 1·5 (2·0)	9	
23. DCE	(3·0) 4·6 (8·0)	96	(3·0) 6·4 (13·0)	72	(1·0) 1·3 (2·3)	72	Short	–	(1·5) 2·4 (4·0)	100	(9·0) 12·5 (20·0)	2·1	100	(1·0) 1·3 (2·0)	21	
24. C5	(1·0) 2·1 (4·0)	72	(3·5) 7·4 (15·0)	90	– – –	–	Long	–	(1·3) 1·9 (3·0)	93	(8·0) 10·7 (15·0)	1·5	58	– 1·0 –	3	
25. B21	(1·0) 1·6 (2·0) incM	96	(1·0) 1·7 (2·0) incM	33	(1·0) 1·1 (1·5)	33	Long	+	(0·3) 0·6 (1·0)	99	(4·0) 5·7 (9·0)	1·1	99	(0·4) 0·7 (1·0)	28	
26. A5T	(1·0) 2·0 (3·0)	87	– – –	–	– 1·0 –	31	Short	–	(1·3) 1·9 (2·5)	100	(8·0) 10·8 (15·0)	1·3	96	(0·5) 1·1 (1·5)	35	
27. C6	(1·5) 2·8 (5·5) incM	77	2·5 (4·4) 8·0	56	– – –	–	Long	+or−	(1·0) 3·2 (7·0)	98	– – –	–	–	(1·5) 2·4 (3·5)	7	
28. DG	(2·0) 2·8 (4·5)	97	2·0 (3·6) 5·5	75	(1·0) 1·3 (2·2)	75	Long	–	(0·5) 1·0 (1·7)	100	(4·0) 6·2 (9·0)	1·0	88	(0·7) 0·9 (1·0)	4	

19 CICATR *A6*

Plate 68; text-fig. 1

Description. Prominent lips (figs. 1, 2, 3). Proximal face: some specimens have a small smooth contact area. Proximal muri: three interradial sets of 3–5. Polar view: (0) 3 (5) muri (in profile) cross the radial margin (figs. 1, 3). Distal muri form an asymmetrical pattern of three sets of 1–15 muri (figs. 6, 7). Sub-parallel distal muri rare. Muri are sinuous and often bifurcate (fig. 7).

Local distinction. 1 CICATR *AT* has more muri which are straight not sinuous and a thicker exine.

20 CICATR *DD*

Plate 69; text-fig. 1

Description. Contact area smooth and often encompasses all of the laesura (figs. 1, 2). Lips thick (fig. 2). Proximal muri: three interradial sets of (1) 2 (3). The distal mural pattern, of three sets of 1–5 (fig. 6) or a sub-parallel set of 4–9 muri (fig. 8), is distinguished by radial lumina each flanked by two muri which project beyond the radial margin (figs. 1, 2, 3, 5, 6, 9).

Local distinction. 18 CICATR *C3* is smaller with no radial lumen. 5 CICATR *A2* is smaller with thicker positive muri. 22 CICATR *DB* has no radial lumen.

21 CICATR *C4*

Plate 70; text-fig. 1

Description. Convexity of amb shape distinctive. Small smooth contact area (figs. 3, 5). Proximal muri: three interradial sets of commonly 3–4. Distal mural pattern normally 12–20 sub-parallel muri (fig. 9), rarely three sets. Radial equatorial extensions conical in shape, ratio length/width at half-length: (0·5) 0·9 (1·7) (74). Proximally the extensions are unsculptured but on the distal side the muri extend across the extensions (figs. 1, 7).

Local distinction. 24 CICATR *C5* has denser and more elongate extensions. The amb has straighter sides and there are a lower number of muri.

EXPLANATION OF PLATE 68

Magnification of figs. 1–9, ×1000; fig. 10, ×2000.

Figs. 1–10. Biorecord 19 CICATR *A6*. 1, Proximal aspect; V500/6, OR 33·7 113·5. 2, Proximal aspect; V500/6, OR 34·5 124·5. 3, Proximal aspect; V500/5, OR 63·6 127·2. 4, Proximal aspect; V500/6, OR 24·4 120·4. 5, Distal aspect, low focus; V500/6, OR 41·9 112·3. 6, Distal aspect; V500/5, OR 36·0 115·0. 7, Distal aspect; V500/5, OR 49·8 113·3. 8, Equatorial aspect; V500/5, OR 53·5 117·8. 9, Equatorial aspect; V500/5, OR 52·5 114·0. 10, Part of oblique aspect, showing mural profile; V500/6, OR 35·4 110·7.

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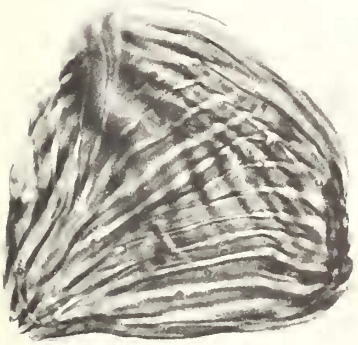

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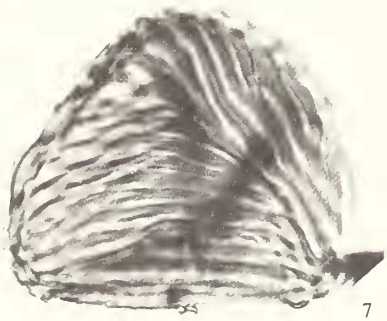

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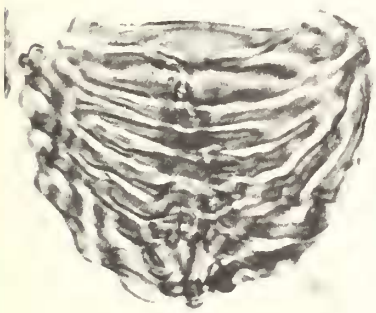

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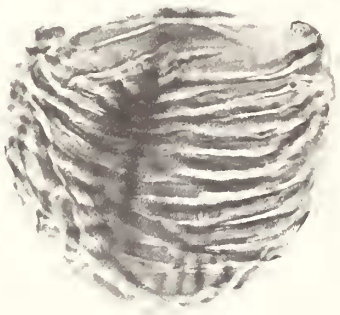

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HUGHES and CROXTON, biorecord 19 CICATR *A6*

EXPLANATION OF PLATE 69

Magnification of figs. 1–9, ×1000; fig. 10, ×2000.

Figs. 1–10. Biorecord 20 CICATR *DD*, Slide V963/4. 1, Proximal aspect; OR 40·3 121·0. 2, Distal aspect, low focus; OR 27·5 108·5. 3, Distal aspect; OR 37·6 110·3. 4, Equatorial aspect; OR 30·2 120·1. 5, Proximal aspect; OR 38·7 127·8. 6, Distal aspect; OR 39·6 124·0. 7, 8, Proximal aspect, high and low focus; OR 38·8 119·3. 9, Distal aspect; OR 37·6 110·1. 10, Part of equatorial view, showing mural profile; OR 38·0 112·0.


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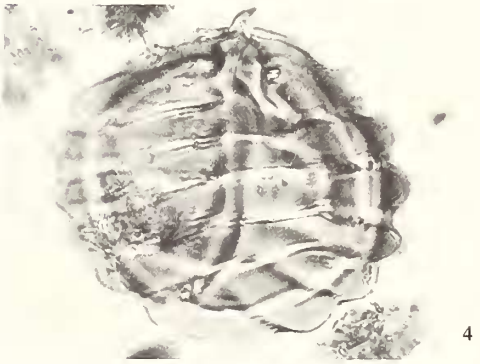
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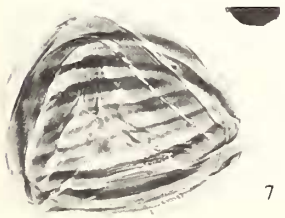
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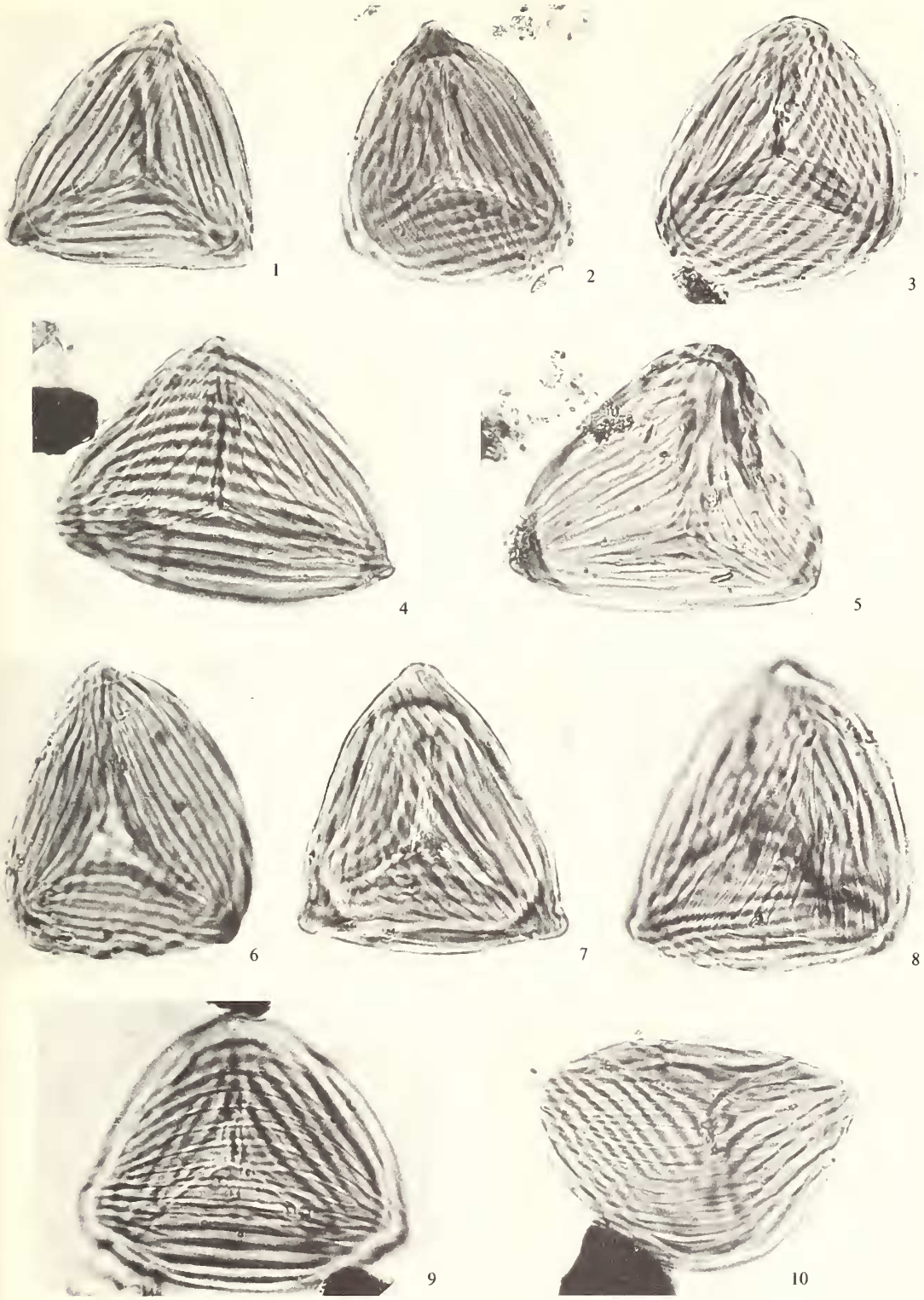
HUGHES and CROXTON, biorecord 20 CICATR *DD*

EXPLANATION OF PLATE 70

Magnification, ×1000.

Figs. 1–10. Biorecord 21 CICATR *C4*. 1, Distal aspect, low focus; V963/2, OR 24·0 108·4. 2, Distal aspect, low focus; V963/3, OR 42·2 117·5. 3, Proximal aspect; V963/4, OR 52·7 123·2. 4, Proximal aspect; V963/2, OR 33·6 129·2. 5, Distal aspect, low focus; V963/4, OR 50·8 122·7. 6, Distal aspect, low focus; V103/1, OR 38·4 113·3. 7, Proximal aspect, low focus; V963/4, OR 51·5 115·5. 8, Distal aspect; V963/4, OR 28·6 111·0. 9, Distal aspect; V963/4, OR 53·0 124·1. 10, Equatorial aspect; V963/4, OR 34·6 127·4.



HUGHES and CROXTON, biorecord 21 CICATR *C4*

22 CICATR *DB*

Plate 71; text-fig. 1

Description. Proximal muri: three interradial sets of 2–4. Distal muri: 4–8 subparallel muri or three sets of muri in an asymmetrical pattern (figs. 4, 7). This taxon includes specimens with conical radial equatorial extensions grading into those with no extension (figs. 2, 7). All specimens in this case have drillings in the muri and they are therefore thought to be primary.

Local distinction. 9 CICATR *AP* is a similar size but the muri are narrower and more numerous. 20 CICATR *DD* differs in mural profile and the distinctive radial lumen.

23 CICATR *DCE*

Plate 72; text-fig. 1

Description. No lips have been distinguished. No unsculptured area. Proximal muri: three interradial sets of 3–15. In the radial equatorial area the lumina are discontinuous forming an interlocking pattern beyond the laesura (fig. 7). Distal face strongly convex and (13) 20 (30) muri bifurcate to accommodate this (figs. 3, 8. 9).

Local distinction. 10 CICATR *A5S* is smaller with fewer muri and a different radial equatorial and distal mural pattern.

24 CICATR *C5*

Plate 73; text-fig. 1

Description. Prominent lips (fig. 2). Proximal muri: three interradial sets of approximately 3. Distal mural pattern normally three sets of up to 14 muri (fig. 7). Radial equatorial extensions are unsculptured and are long, narrow, and tapering. Ratio length/width at half-length: (1·1) 1·8 (4·0) (78).

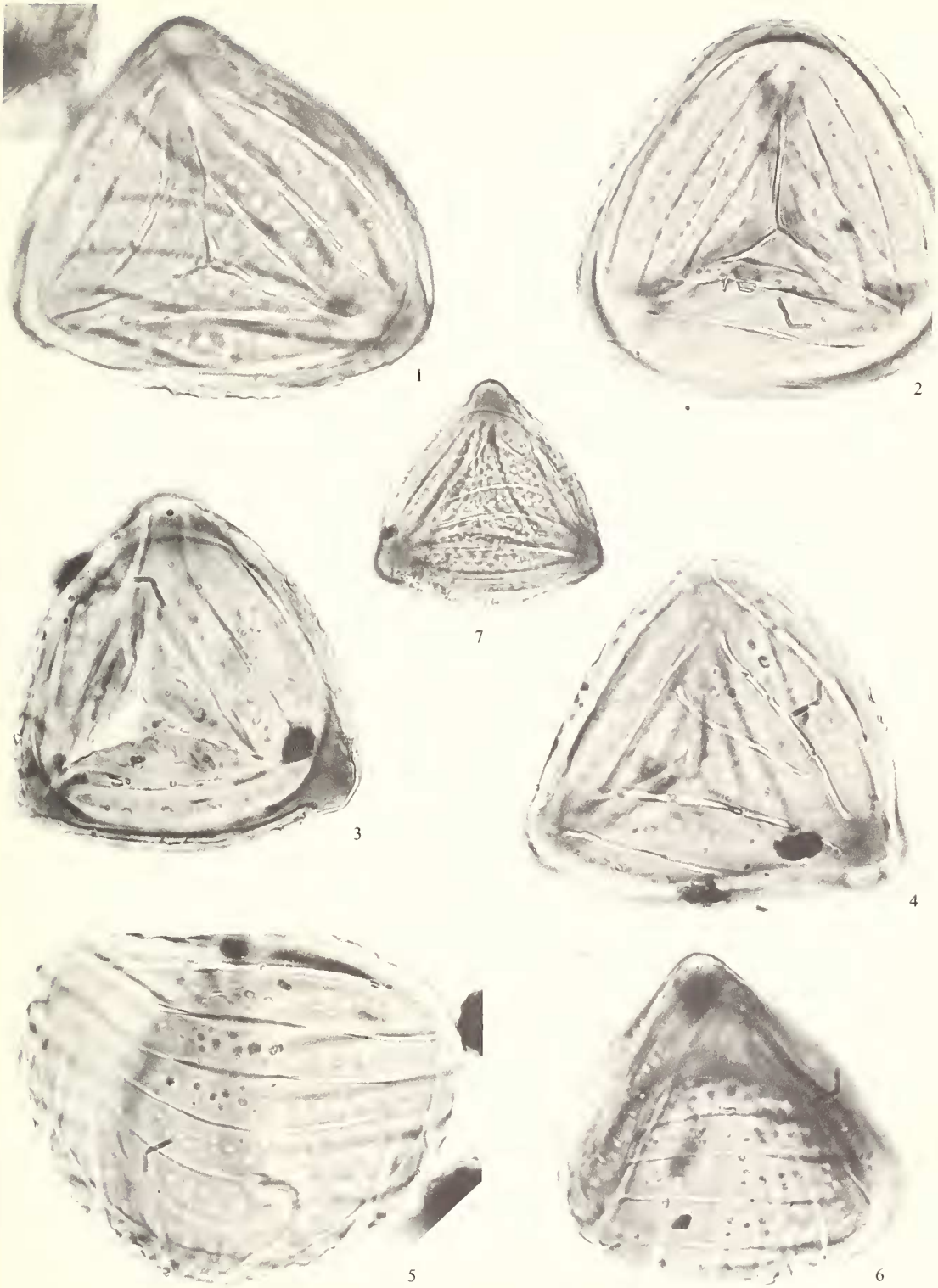
Preservation. Some specimens have 'drillings' that appear to be corrosion (fig. 9).

Local distinction. 8 CICATR *C2* has 'knob-like' rather than tapering extensions and is smaller. 21 CICATR *C4* has shorter, more conical extensions which are sculptured distally; the amb is more convex-sided and there are more muri.

EXPLANATION OF PLATE 71

Magnification of figs. 1–6, ×1000; fig. 7, ×500.

Figs. 1–7. Biorecord 22 CICATR *DB*. 1, Proximal aspect; JO35/3, OR 49·6 115·0. 2, Proximal aspect; V963/1, OR 40·1 116·8. 3, Distal aspect, low focus; V103/1, OR 40·5 112·2. 4, Distal aspect; V103/3, OR 36·7 113·8. 5, Equatorial aspect; V963/3, OR 55·8 110·6. 6, Oblique aspect; V963/2, OR 33·3 117·1. 7, Distal aspect; V963/2, OR 37·4 117·7.

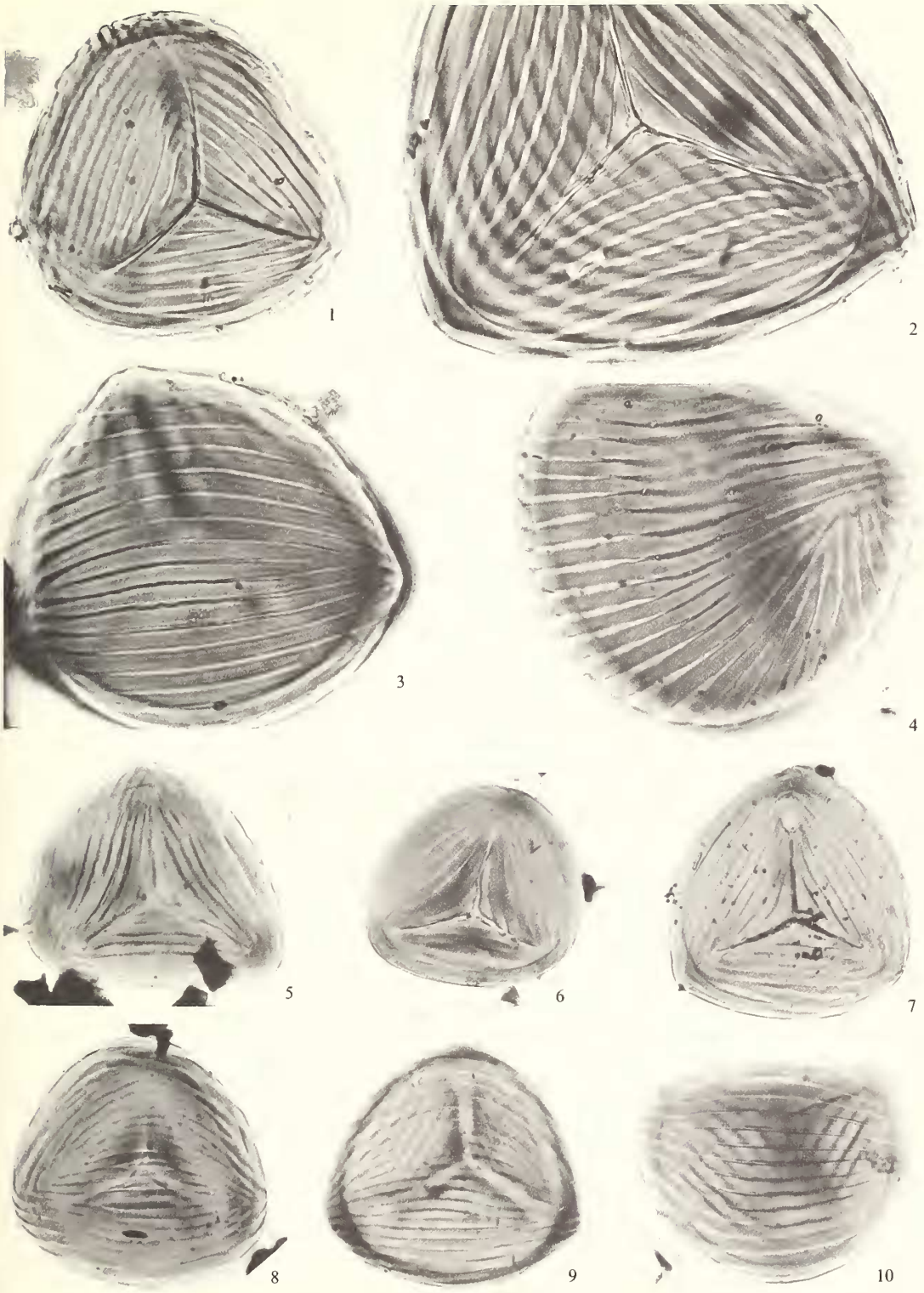


HUGHES and CROXTON, biorecord 22 CICATR *DB*

EXPLANATION OF PLATE 72

Magnification of figs. 1–4, ×1000; figs. 5–10, ×500.

Figs. 1–10. Biorecord 23 CICATR *DCE*. 1, Proximal aspect; W103/2, OR 32·5 106·8. 2, Proximal aspect; V963/2, OR 26·6 125·7. 3, Distal aspect; V963/3, OR 47·9 124·9. 4, Equatorial aspect; V963/3, OR 55·0 124·8. 5, Proximal aspect; V963/4, OR 49·8 118·9. 6, Proximal aspect; V963/4, OR 43·7 120·3. 7, Proximal aspect; W103/1, OR 31·7 111·6. 8, Distal aspect; V963/3, OR 40·3 129·0. 9, Distal aspect; V963/3, OR 47·4 121·2. 10, Oblique aspect; V963/3, OR 30·2 129·2.

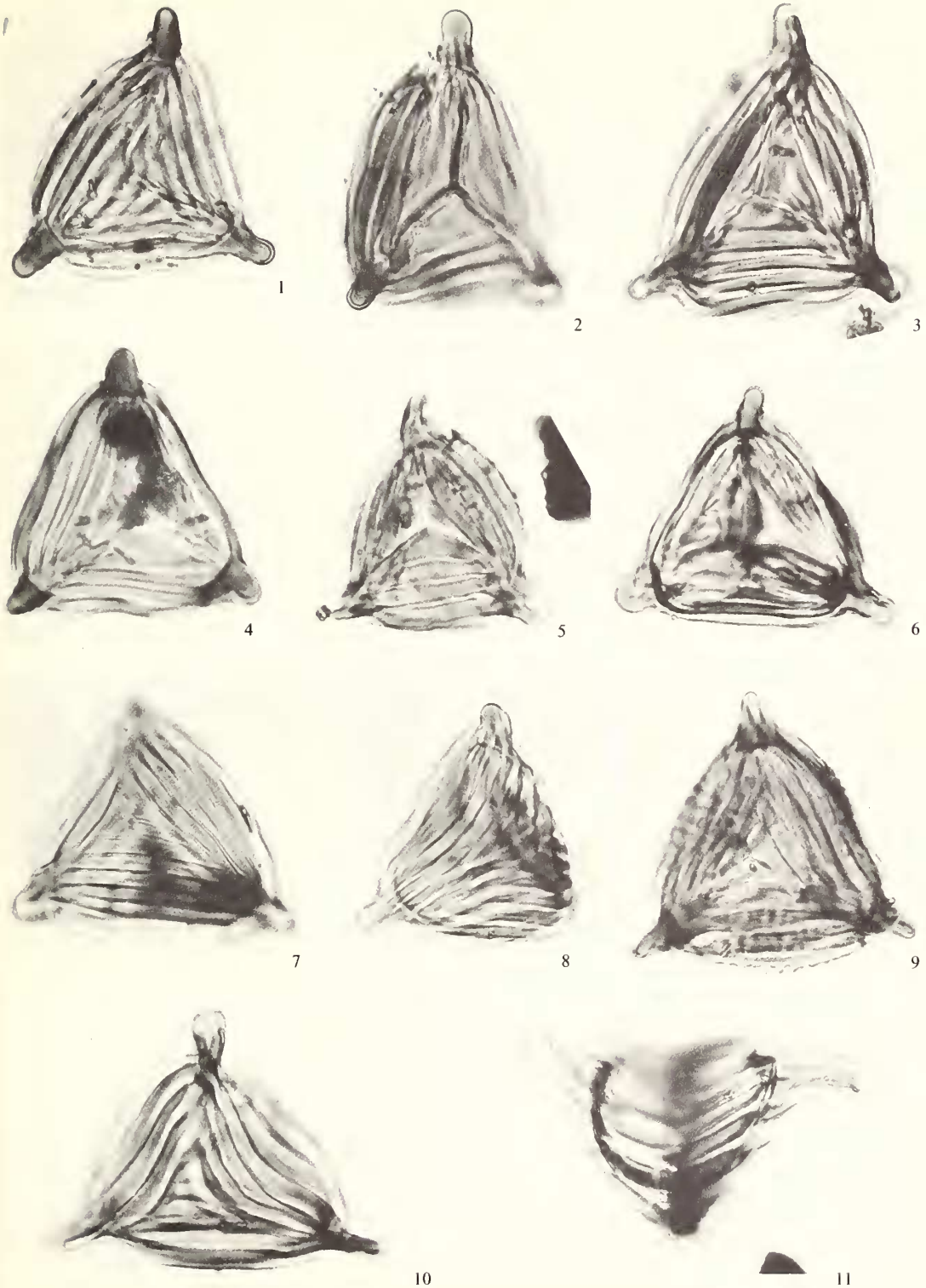


HUGHES and CROXTON, biorecord 23 CICATR *DCE*

EXPLANATION OF PLATE 73

Magnification, ×1000.

Figs. 1–11. Biorecord 24 CICATR *C5*. 1, Proximal aspect; W190/3, OR 35·2 123·6. 2, Proximal aspect; W190/4, OR 48·2 116·0. 3, Distal aspect, low focus; W190/2, OR 52·2 104·5. 4, Distal aspect, low focus; W190/5, OR 38·7 119·6. 5, Distal aspect, low focus; W190/6, OR 44·6 122·6. 6, Distal aspect, low focus; W190/2, OR 25·1 116·9. 7, Distal aspect; W190/5, OR 38·7 119·6. 8, Distal aspect; W190/5, OR 40·0 111·8. 9, Distal aspect; W190/5, OR 42·1 122·5. 10, Distal aspect; W190/6, OR 29·4 122·7. 11, Equatorial aspect; W190/6, OR 30·7 109·4.



HUGHES and CROXTON, biorecord 24 CICATR *C5*

25 CICATR *B21*

Plate 74; text-fig. 1

Description. Proximal face has a small smooth apical area (figs. 2, 3). Proximal muri (12–16) are in three sets oblique to the edge of the amb and meet the laesura at an angle (anticlockwise swirl) (figs. 1, 3, 6). Distal mural pattern is three asymmetrical sets of 8–12 muri or 20–25 sub-parallel bifurcating muri. Distal muri may also show clockwise swirl.

Local distinction. 17 CICATR *B20* is smaller, has larger and fewer muri. 28 CICATR *DG* has wider negative muri and a thicker exine. In neither of the above have 'swirling' proximal muri been observed.

26 CICATR *A5T*

Plate 75; text-fig. 1

Description. Some specimens have a smooth contact area (figs. 2, 3). Proximal muri: three interradial sets of 3–7. Outer proximal muri continuous round ends of laesura (figs. 1, 2, 3, 4). Distal muri: 12–20 in a sweeping 'parabolic' pattern (figs. 8, 9).

Local distinction. 10 CICATR *A5S* is smaller, has narrower lumina, rectangular mural profile, thicker exine, and circular lumina occur in the distal mural pattern.

27 CICATR *C6*

Plate 76; text-fig. 1

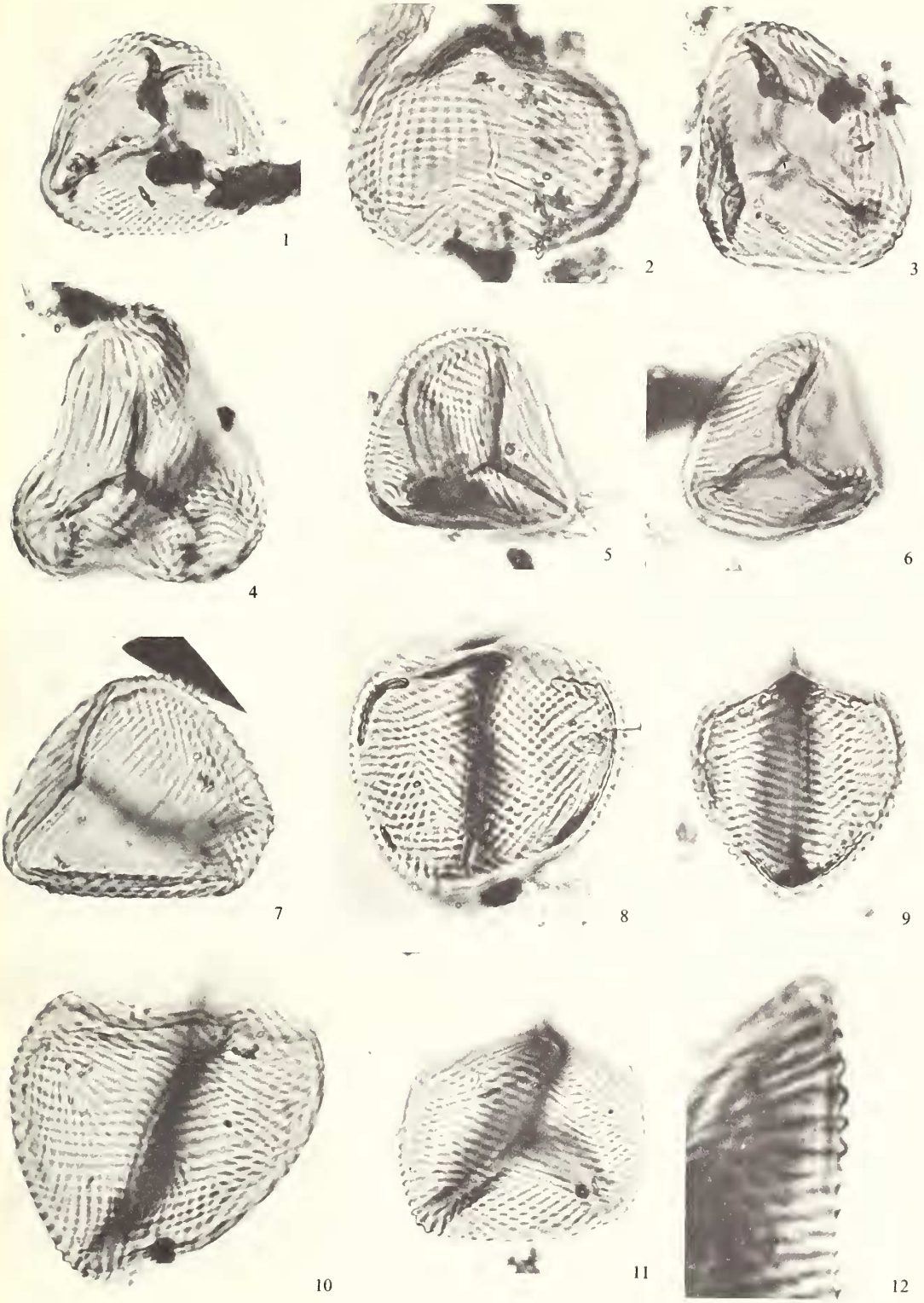
Description. Interradial exine thickness may vary in the same specimen (fig. 6). Smooth contact area covering most of the proximal face (fig. 3). Sculpture may be positive or negative, width of one lumen: (1·0) 2·9 μm (8·0) (92). Distal muri: three asymmetrical sets of 1–7. Radial equatorial extensions variable: conical, tapering, or 'flattened'; in some specimens they are not very prominent. Ratio length/width at half-length: (0·6) 1·0 (1·7) (48).

Local distinction. 18 CICATR *C3* has wider negative muri with a rectangular mural profile and more prominent and uniform radial extensions. 7 CICATR *C1* has more numerous narrower muri.

EXPLANATION OF PLATE 74

Magnification of figs. 1–11, ×1000; fig. 12, ×2000.

Figs. 1–12. Biorecord 25 CICATR *B21*. 1, Proximal aspect; W190/4, OR 26·2 116·3. 2, Distal aspect, low focus; W190/4, OR 35·5 116·7. 3, Proximal aspect; W190/2, OR 53·1 115·2. 4, Proximal aspect; W190/6, OR 30·3 109·3. 5, Proximal aspect; W190/1, OR 59·6 124·4. 6, Proximal aspect; W190/5, OR 33·5 123·9. 7, Distal aspect; W190/6, OR 53·9 118·0. 8, Equatorial aspect; W190/2, OR 27·1 123·3. 9, Equatorial aspect; W190/4, OR 36·6 125·3. 10, Equatorial aspect; W190/4, OR 51·6 123·1. 11, Oblique aspect; W190/4, OR 29·0 125·1. 12, Part of oblique aspect, showing mural profile; W190/4, OR 33·2 121·8.



HUGHES and CROXTON, biorecord 25 CICATR *B21*

EXPLANATION OF PLATE 75

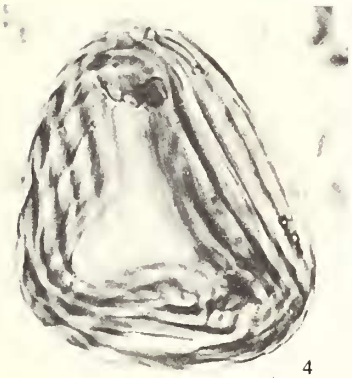
Magnification, ×1000.

Figs. 1–12. Biorecord 26 CICATR *A5T*. 1, Proximal aspect; V197/5, OR 29·1 121·0. 2, Distal aspect, low focus; V197/5, OR 41·9 125·3. 3, Proximal aspect; V197/4, OR 32·6 117·7. 4, Proximal aspect; V197/6, OR 55·0 113·2. 5, Distal aspect; V197/7, OR 37·9 117·0. 6, Proximal aspect, low focus; V197/4, OR 58·4 104·5. 7, Distal aspect; V197/4, OR 33·1 112·6. 8, Distal aspect; V197/4, OR 26·8 122·3. 9, Distal aspect; V197/4, OR 54·7 112·3. 10, Equatorial aspect; V197/6, OR 26·0 123·0. 11, Equatorial aspect; V197/6, OR 28·2 105·7. 12, Oblique aspect; V197/4, OR 57·3 127·0.


1


2


3


4


5


6


7


8


9


10


11

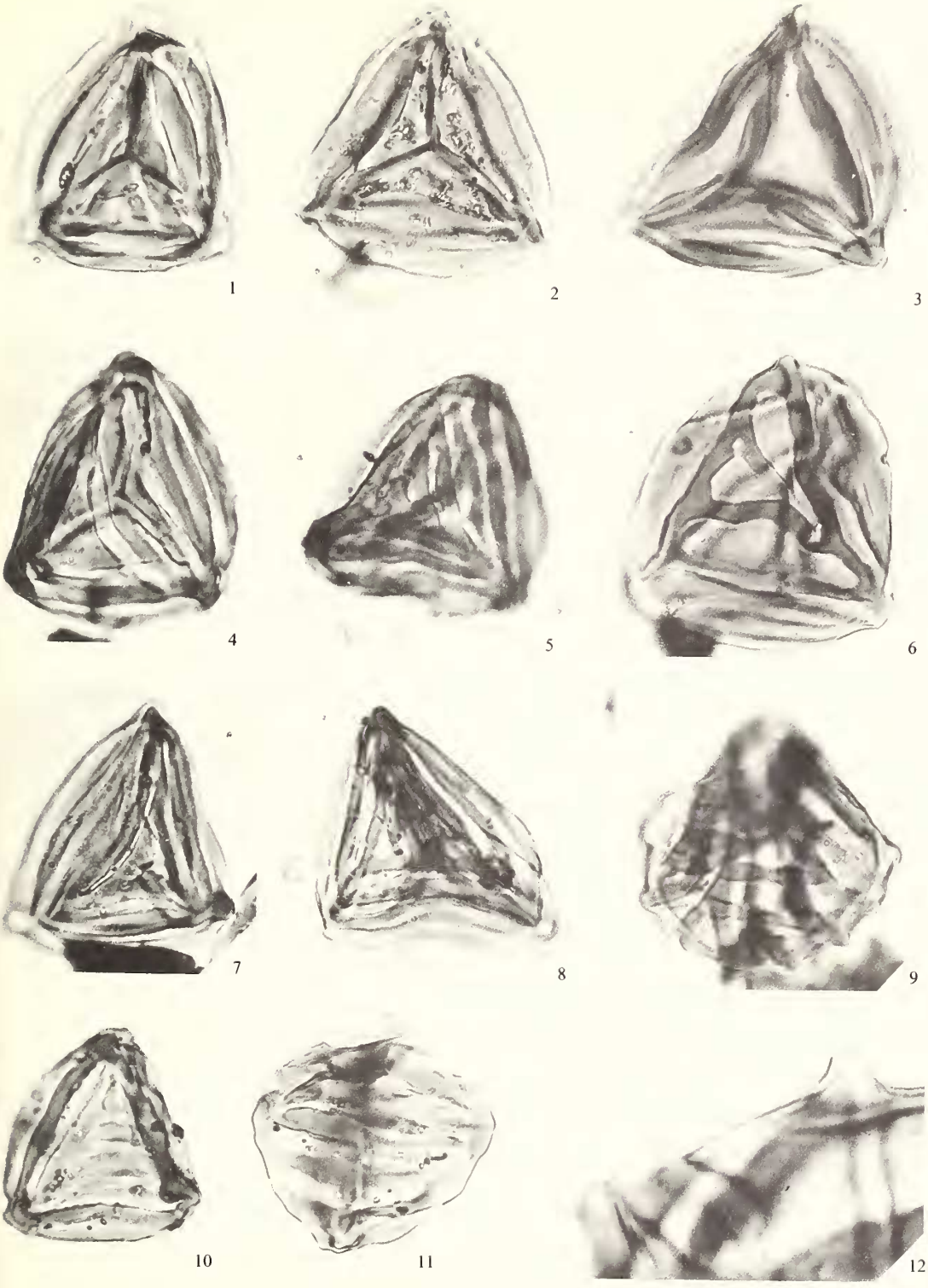

12

HUGHES and CROXTON, biorecord 26 CICATR *A5T*

EXPLANATION OF PLATE 76

Magnification of figs. 1–11, ×1000; fig. 12, ×2000.

Figs. 1–12. Biorecord 27 CICATR *C6*. 1, Proximal aspect; V198/3, OR 30·2 109·8. 2, Proximal aspect; V198/2, OR 42·1 117·4. 3, Proximal aspect; V198/2, OR 37·1 121·0. 4, Distal aspect; W262/1, OR 28·6 110·8. 5, Proximal aspect, low focus; V198/2, OR 14·8 110·5. 6, Distal aspect; V198/3, OR 57·1 108·9. 7, Distal aspect; V198/4, OR 51·3 126·6. 8, Distal aspect; V198/2, OR 37·5 112·3. 9, Oblique aspect; W262/3, OR 60·7 125·7. 10, Distal aspect; V198/1, OR 43·3 125·3. 11, Equatorial aspect; V198/1, OR 33·1 122·0. 12, Part of oblique aspect, showing mural profile; V198/4, OR 48·0 115·1.

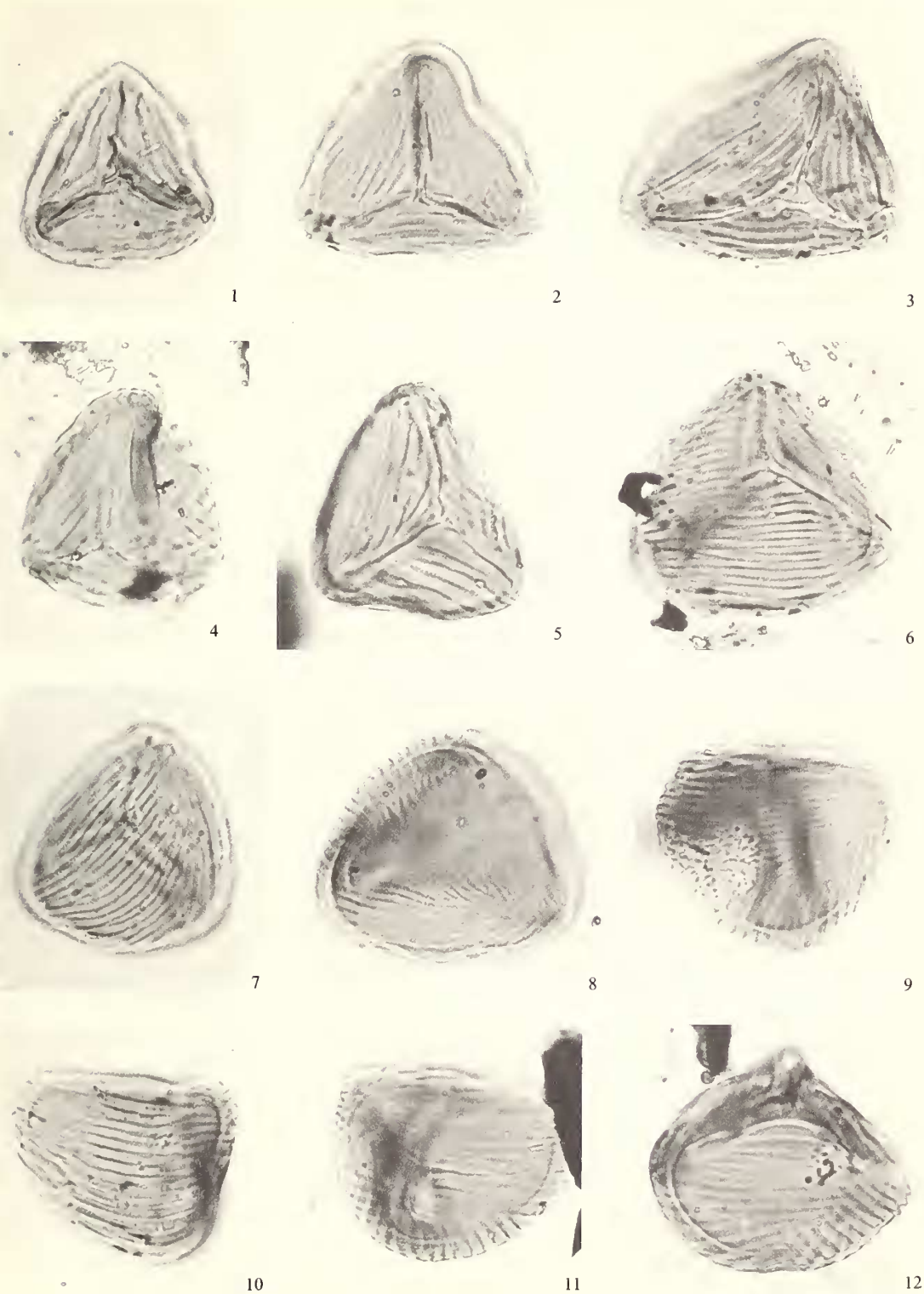


HUGHES and CROXTON, biorecord 27 CICATR *C6*

EXPLANATION OF PLATE 77

Magnification, × 1000.

Figs. 1–12. Biorecord 28 CICATR *DG*. 1, Proximal aspect; WO58/2, OR 56·6 119·1. 2, Proximal aspect; WO58/7, OR 45·5 113·0. 3, Proximal aspect; WO58/1, OR 31·4 115·2. 4, Distal aspect, low focus; WO58/2, OR 46·9 114·5. 5, Distal aspect, low focus; WO58/1, OR 35·8 102·4. 6, Distal aspect, low focus; WO58/1, OR 51·6 106·9. 7, Distal aspect; WO58/3, OR 54·3 107·2. 8, Distal aspect; WO58/7, OR 51·6 123·9. 9, Equatorial aspect; WO58/8, OR 34·7 112·2. 10, Equatorial aspect; WO58/7, OR 41·6 117·3. 11, Equatorial aspect; WO58/8, OR 39·3 121·9. 12, Oblique aspect; WO58/2, OR 40·6 110·6.



HUGHES and CROXTON, biorecord 28 CICATR *DG*

28 CICATR *DG*

Plate 77; text-fig. 1

Description. Laesura may be sinuous (fig. 1). No smooth contact area distinguished. Proximal muri: three interradial sets of 15–16. Distal mural pattern: 18–25 subparallel muri.

Local distinction. 17 CICATR *B20* is smaller with a thinner exine and positive sculpture. 25 CICATR *B21* has narrower positive muri and a thinner exine, also 'swirling' proximal muri.

SYSTEMATIC DESCRIPTION OF THE EVENTS

The palynologic events are composed of comparison records graded A and B, or ungraded either if the number of specimens used was below twenty-five or if preservation was imperfect. The details are given in Tables 3–5.

Revised event. In the case of sample *WM1740/6* from which Event 53 was raised (Hughes and Moody-Stuart 1969), further preparations have been studied and the constituent taxa reviewed; a new event number (81), which in effect bears the date 1972, has therefore been allotted for the new information although it has been taken from the same rock sample. In contrast the Events 43 (*WM1819/5*) and 36 (*WM1843*) have been used again; the details of these two have been presented in Table 3 for convenience of use with new events.

Unworked taxa. The column headed 'others' on the right of Tables 3 and 4 contains records, in addition to those of rare unplaceable specimens, of spores which we would previously have placed in comparison cfC. to an existing biorecord. Such records implied presumed new taxa which were not, however, made into biorecords as they were not needed for comparison in the present project, thus saving considerable time. Percentages in this category are occasionally high as in Event 100 (Table 3) or 112 (Table 4) in which in each case there were high numbers of forms not subsequently seen elsewhere. Unpublished details are filed. We feel that this principle could be applied with saving elsewhere in palynologic publication.

EVENT CORRELATION

The selected Worbarrow events are correlated individually with the reference scale section at Warlingham (text-fig. 2) by means of a bracket in each case; the bracket consists of the two statements 'After reference event X' and 'Before reference event Y'. In theory such a statement may be refined subsequently up to the limits of rock sampling. No attempt is made to *equate* a Worbarrow event with a reference event as this is logically impossible.

The points considered to be critical in each correlation are set out below but the list should be read in conjunction with Tables 3–5.

105 EVENT *W128*: between events 36 *WM1843* and 72 *WM1795*; occurrence of both cf. 6 *B5* and cf. 8 *C2* (suggesting proximity to event 43 *WM1819/5*); high percentages cfA. 1 *AT*, cfA. 4 *AW*, and cfA. 7 *C1*; absence of cf. 10 *A5S* and cf. 17 *B20*.

TABLE 3. Event composition data for Warlingham Borehole reference scale. In comparison tabulation, larger numerals indicate biorecord from that sample. CON = '*Contignisporites*'.

Event		Prep-aration	Palynologic Facies								% Cicatricosisporites group present																						
			%					Fern spore size index			Biorecords and their comparisons																						
No.	Sample		Cics	Other Ferns	Bisaccates	Classopollis	Other	<30	30-50	>50 µm	1 AT	3 AR	4 AW	5 A2	6 B5	7 C1	8 C2	9 AP	10 A5S	17 B20	18 C3	19 A6	20 DD	21 C4	22 DB	23 DCE	24 C5	25 B21	26 A5T	27 C6	28 DG	CON	Others
103	WM 1060/9	W 235/1,2	13	47	18	2	20	39	55	6							5 cf.		20 cfB.	9 cf.	8 cf.	2 cf.		3 cf.	1 cf.		4 cf.			7 cf.			41
101	WM 1153/2-8	W 065/2	10	51	25	–	14	37	53	10							4 cf.		19 cfB.			7 cf.		3 cf.			9 cfA.	8 cfB.	20 cfA.	13 cfA.	6 cf.		11
100	WM 1217/6	W 058/2	12	34	25	1	28	23	51	26			3 cf.							5 cf.	3 cf.			10 cf.	1 cf.		2 cf.	4 cf.		10 cfA.	11	1	50
99	WM 1275/6	W 070/1	13	33	28	6	20	24	71	5							3 cf.		14 cfB.	3 cf.				6 cf.			7 cf.	7 cf.	6 cf.	29 cfA.	10 cfA.		15
98	WM 1319/2	W 107/3	8	34	45	1	12	28	63	9						4 cf.	2 cf.		9 cfB.	21 cfB.	1 cf.				3 cf.		3 cf.	10 cfB.	9 cfA.	18 cfA.			20
97	WM 1394/1	W 055/2	11	36	23	16	14	18	72	10									18 cfB.	8 cf.	3 cf.			3 cf.			2 cf.		53 cfA.	3 cf.			10
96	WM 1415/3	V 963/4	27	32	12	12	17	18	51	31								1 cf.			3 cf.		63	6	4	4		5 cf.					14
94	WM 1456/5	V 958/3	21	54	11	7	7	18	64	18							5 cf.	13 cfB.	22 cfB.	2 cf.	23 cfA.	4 cf.					5 cf.	1 cf.	17 cfB.	5 cf.			3
90	WM 1537	V 947/1,2	7	32	3	8	50	24	57	19	9 cf.			5 cf.		5 cf.	4 cf.		5 cf.	14 cfB.	10 cfA.	15 cfB.	2 cf.	1 cf.	1 cf.	4 cf.	3 cf.	13 cfB.	3 cf.				6
89	WM 1569	V 513/3	10	55	4	10	21	36	55	9	11 cfA.	2 cf.		8 cf.			7 cf.		13 cfB.	31 cfA.	7 cf.						2 cf.		9 cfB.				10
88	WM 1610/6	V 913/3	11	41	7	15	26	23	65	12				1 cf.		2 cf.	6 cf.	1 cf.	9 cfB.	36 cfA.	4 cf.	8 cf.		1 cf.	1 cf.		1 cf.	3 cf.	9 cfB.	2 cf.		1	15
87	WM 1645	V 501/4	11	37	10	33	9	18	61	21			12 cfA.	6 cf.			5 cf.		11 cfA.	27 cfA.	4 cf.	11 cfB.						2 cf.	7 cf.	1 cf.			14
86	WM 1655	K 018/8	11	45	23	8	13	13	67	20	2 cf.	1 cf.	18 cfA.	2 cf.		3 cf.	5 cf.	3 cf.	14 cfA.	33		8 cf.											11
83	WM 1681/6	V 500/4	12	48	31	5	4	10	61	29	11 cfA.		17 cfA.	3 cf.		2 cf.	6 cf.	7 cf.	32 cfA.	16 cfA.		6											
81	WM 1740/6	V 416/4	14	49	17	16	4	4	57	39	7 cfA.		21 cfA.	19 cfA.		25 cfA.	4	3	11	8 cf.	2 cf,												
79	WM 1749/8	V 411/5	9	38	30	14	9	26	47	27	19 cfA.	2 cf.	9 cf.	5 cf		18 cfA.	3 cf.		14 cfA.	12 cfA.	15												3
77	WM 1757	Y 380/11	9	22	37	15	17	26	56	18	7 cf.	2 cf.	33 cfA.	14 cfA.		10	12 cfA.	4 cf.	11 cfA.	3 cf.	3 cf.											1	
72	WM 1795	V 535/5	2	43	30	5	20	46	47	7	9 cf.	5 cf.	57 cfA.	15 cfA.		2 cf.	5 cf.	4 cf.	2 cf.	1 cf.													
43	WM 1819	V 533/1,2	4	47	15	16	18	35	58	7	8 cfA.	10 cfA.	46 cfA.	20 cfA.	2 cfA.	8 cfA.	3 cfA.																3
36	WM 1843	V 016/3	15	24	22	5	34	32	53	15	16 cfA.	11 cfA.	47 cfA.	15		10 cfA		1 cf															

TABLE 4. Event composition data for Worbarrow Bay section. See explanation of Table 3.

Event		Prep-oration	Polynologic Facies								% Cicatricosisporites group present																						
							%	Fern spore size index			Biorecords and their comporisons																						
No.	Somple		Cics	Other Ferns	Bisaccates	Classopollis	Other	<30	30-50	>50 μm	1 AT	3 AR	4 AW	5 A2	6 B5	7 C1	8 C2	9 AP	10 A5S	17 B20	18 C3	19 A6	20 DD	21 C4	22 DB	23 DCE	24 C5	25 B21	26 A5T	27 C6	28 DG	CON	Others
115	W111	W190/2	15	38	31	–	16	29	61	10	14 cfA.					7 cf.			15 cfB.	7 cf.	5 cf.			5 cf.			13	17	9 cfA.		3 cf.		5
114	W9	W197/5	10	35	40	1	14	16	63	21			11 cfA.				1 cf.		34 cfB.		1 cf.	6 cf.		3 cf.		3 cf.	4 cf.	8 cfA.	16	6 cf.			7
112	W12B	V206/2	13	36	3	4	44	18	53	29							1 cf.	3 cf.		6 cf.	8 cf.		2 cf.	5 cf.	4 cf.	1 cf.	6 cf.	11 cfA.		11 cfA.		1	41
111	W14	V198/3	11	39	10	7	33	19	43	38						2 cf.			10 cfB.			5 cf.		1 cf.	6 cfA.	7 cfB.	2 cf.	14 cfA.		16		8	29
110	W2	V192/2	13	34	30	1	22	19	54	27			7 cf.	9 cfB.			2 cf.		11 cfB.	6 cf.	4 cf.			1 cf.			2 cf.	2 cf.	35 cfA.			4	17
109	W15	W131/1	16	34	31	2	17	15	56	29			18 cfA.	2 cf.		3 cf.	2 cf.		24 cfA.	28 cfA.	1 cf.	10 cfA.										2	10
108	W121	W172/2	11	14	3	64	8	15	64	21	5 cf.		46 cfA.	5 cf.		2 cf.	2 cf.		25 cfA.	5 cf.	2 cf.			5 cf.								2	1
107	W18	V200/4	6	44	38	–	12	14	48	38	18 cfA.		47 cfA.	2 cf.		21 cfA.	1 cf.															4	7
106	W124	W180/3	5	23	2	68	2	11	55	34	13 cfA		13 cfA.			29 cfA.	15 cfA.	7 cf															23
105	W128	W184/2	8	38	3	24	27	15	42	43	14 cfA.		11 cfA	4 cf.	6 cf.	33 cfA.	9 cf															3	20

TABLE 5. Preparation data for events.

Sample	Event	Biorecords	Prep-aration	Preparation Details		
				Oxidation Cold con.HNO_3	Min Sep.	Short Cent.
WM 1394/1	97		W 055	30 mins	✓	✓
WM 1415/3	96	20.DD,21.C4	V 963	20 mins	✓	✓
		22.D8,23DCE	W 103	30 mins	✓	✓
			J 035	30 mins	✓	-
WM 1456/5	94		V 958	25 mins	✓	✓
WM 1537	90		V 947	20 mins	✓	✓
WM 1569	89		V 513	20 mins	✓	✓
WM 1610/6	88		V 913	30 mins	✓	✓
WM 1645	87		V 501	25 mins	✓	✓
WM 1655	86	17. B20	K 018	20 mins	✓	-
WM 1681/6	83	19. A6	V 500	25 mins	✓	✓
WM 1740/6	81		V 416	25 mins	✓	✓
WM 1749/8	79	18.C3	V 411	15 mins	✓	✓
WM 1757	77		Y 380	60 mins (S)	✓	-
WM 1795	72		V 535	25 mins	✓	✓
WM 1819/5	43		V 533	25 mins	✓	-
WM 1843	36		V 016	10 mins	✓	-

(S)= Schulze's solution

Sample	Event	Biorecords	Prep-aration	Preparation Details		
				Oxidation Cold con.HNO_3	Min Sep.	Short Cent.
W 111	115	24.C5,25.B21	W 190	10 mins	✓	✓
W 9	114	26. A5T	W 197	10 mins	✓	✓
W 12B	112		V 206	30 mins	✓	-
W 14	111	27. C6	V 198	30 mins	✓	-
			W 262	10 mins	✓	✓
W 2	110		V 192	30 mins	✓	-
W 15	109		W 131	10 mins	✓	✓
W 121	108		W 172	10 mins	✓	✓
W 18	107		V 200	25 mins	✓	-
W 124	106		W 180	10 mins	✓	✓
W 128	105		W 184	10 mins	✓	✓
WM 1060/9	103		W 235	10 mins	✓	✓
WM 1153/2-8	101		W 065	30 mins	✓	✓
WM 1217/6	100	28. DG	W 058	30 mins	✓	✓
WM 1275/6	99		W 070	30 mins	✓	✓
WM 1319/2	98		W 107	20 mins	✓	✓

106 EVENT *W124* and 107 EVENT *W18*: technically also between events 36 *WM1843* and 72 *WM1795*, but probably after event 43 *WM1819/5* on superposition and on absence of cf. 6 *B5* in spite of comparable 'fern spore size index' with event 105 *W128* (see above).

108 EVENT *W121*: between events 72 *WM1795* and 83 *WM1681/6*; occurrence of cf. 18 *C3*, but not of cf. 19 *A6́*; high percentages of cfA. 10 *A5S* and cfA. 4 *AW*.

109 EVENT *W15*: between events 81 *WM1740/6* and 87 *WM1645*; occurrence of cfA. 19 *A6*, but not cf. 24 *C5*, cf. 25 *B21*, or cf. 26 *A5T*; high percentages of cfA. 10 *A5S*, and cfA. 17 *B20*.

110 EVENT *W2*: between events 86 *WM1655* and 90 *WM1537*; occurrence of cf. 24 *C5*, cf. 25 *B21*, and cf. 26 *A5T*, but not of cf. 20 *DD* and cf. 23 *DCE*; last occurrence of cf. 5 *A2*.

111 EVENT *W14*: between events 89 *WM1569* and 97 *WM1394/1*; occurrence of cf. 22 *DB*, cf. 23 *DCE*, and cf. 27 *C6*.

112 EVENT *W12B*: between events 89 *WM1569* and 97 *WM1394/1*; occurrence of cf. 20 *DD*, cf. 22 *DB*, cf. 23 *DCE*, and cf. 27 *C6*; last occurrence of cf. 9 *AP*.

114 EVENT *W9*: between events 96 *WM1415/3* and 99 *WM1215/6*; high percentage of cfA. 26 *A5T*; occurrence of cf. 24 *C5* and cf. 27 *C6*; no record of cf. 20 *DD*, cf. 22 *DB*, or cfA. 28 *DG*.

115 EVENT *W111*: between events 98 *WM1319/2* and 103 *WM1060/9*; occurrence of cf. 28 *DG*, cfA. 26 *A5T*; relatively high percentage of biorecord 24 *C5*.

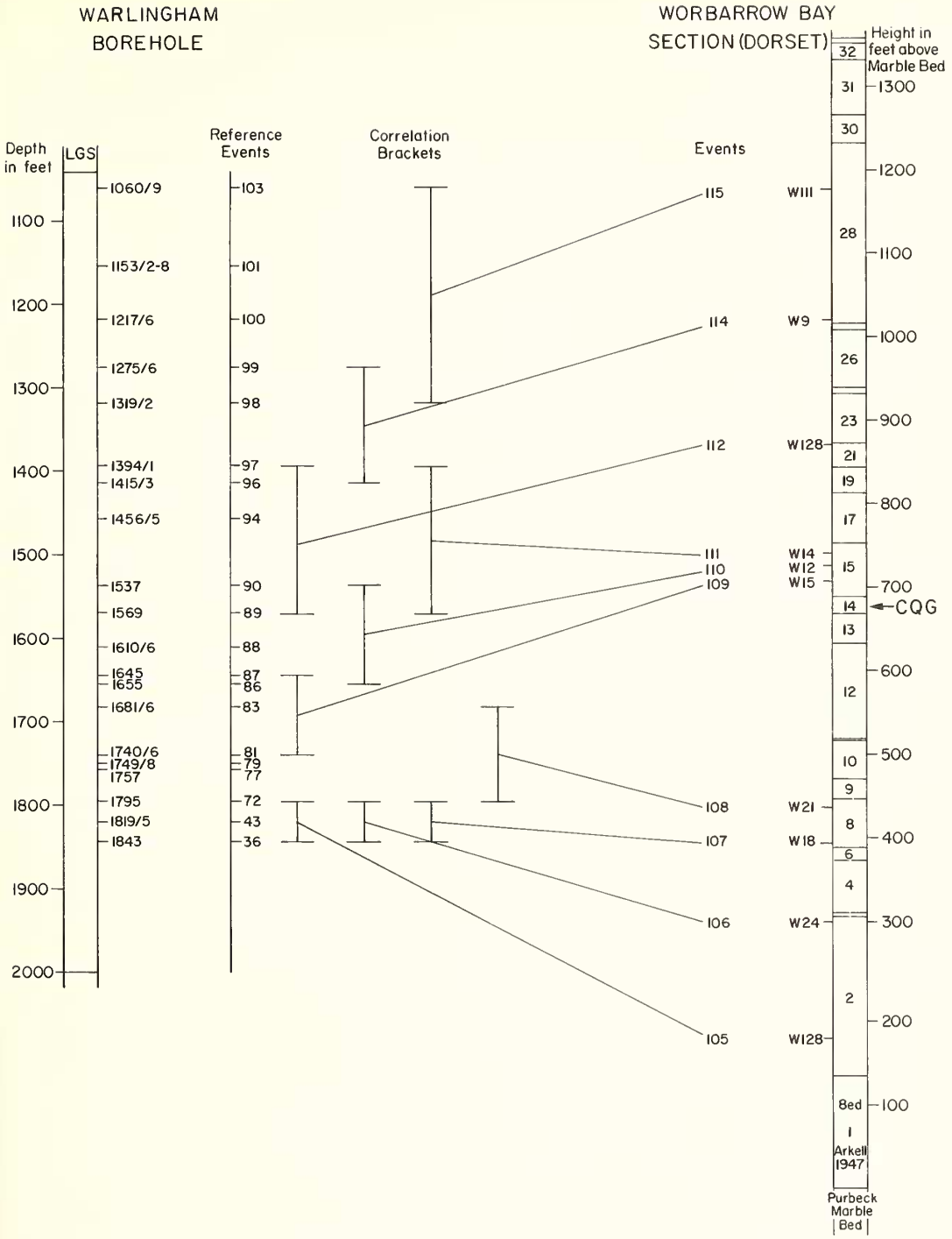
In several cases above, we could guess at a narrower bracket but the proof could not be satisfactorily expressed at this stage, e.g. 105 Event correlation 42/44, 108 Event correlation 77/81, 109 Event correlation 83/86, 112 Event correlation 96/97, 114 Event correlation 97/98, and 115 Event correlation 99/101. It is to be expected that the application of further data from other spores would supply proof, and this process would comprise the progressive refinement or narrowing of the brackets for which we intend to provide.

As will be seen from the event numbering system there are many intermediate events in the reference scale but they are not quoted because they are not rich enough in *Cicatricosisporites* group spores to bear on the current problem; in most of these cases the fern spore size index shows low percentages of spores over 50 μm diameter.

STRATIGRAPHIC CONCLUSIONS

The 'Coarse Quartz Grit' of Worbarrow Bay (Arkell 1947, Bed 14) appears to fall between events 81 and 83 on the Warlingham scale approximately around 1700 ft depth in the borehole. Worssam and Ivimey-Cook (1971) of the Institute of Geological Sciences consider this depth to lie in the Upper Tunbridge Wells Sandstone, based on general lithologic grounds and partly on ostracod correlations. Hughes and Moody-Stuart (1969) made palynologic correlations that suggested that the 1700 ft depth correlated with rocks rather lower in the outcrop succession of the Hastings Beds. Further work will be necessary to reconcile these views, but we suggest that it may not be entirely valid to identify outcrop formations such as the Wadhurst Clay at such a distance from the Central Weald, and near to the basin margin.

The age of the 'Coarse Quartz Grit' is still not better known than late Valanginian/



TEXT-FIG. 2. Diagram to show correlation brackets of ten Worbarrow Bay *Cicatricosisporites* events, on a reference scale of events of similar origin from Warlingham Borehole. CQG = the prominent 'Coarse Quartz Grit'.

early Hauterivian (Hughes 1958). Although this bed is only 20 ft (6 m) thick, it presumably represents some distinct tectonic event in south-west England or perhaps in the then adjacent Iberia (Allen 1972).

COMMENTS ON METHOD

Starting work in a new section. We found it advisable to make provisional biorecords of twenty-five specimens and brief comparison records in the first place, so that the considerable time and effort necessary to make 100 specimen biorecords, etc., could be saved when these were not required for any specific correlation. Observer-time is the only real bottleneck in the procedure.

Assemblage-types (Batten 1973). Samples have not yet been fully analysed in this way, and no mathematical expression has been devised to allow for the effect of the 'Fern Spore Size Index', both on biorecords and on events.

Future work. Supplementation of the present work by use of several other promising groups of palynomorphs in the same way will strengthen and refine these correlation brackets.

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APPENDIX OF SAMPLE DESCRIPTIONS

WARLINGHAM BOREHOLE

Unregistered samples, by courtesy of the Geological Survey in 1956.

WM1060/9	Mudstone, light olive grey (5 Y 6/1); mica. Plant fragments present.
WM1153/2–8	Mudstone, light olive grey (5 Y 6/1), laminated; mica. Plant fragments abundant.
WM1217/6	Siltstone, mottled light olive grey (5 Y 6/1) and yellowish grey (5 Y 7/2), unsorted; mica. Plant fragments common.
WM1275/6	Mudstone, greenish grey (5 GY 6/1), laminated; mica. Plant fragments present.
WM1319/2	Mudstone, light olive grey (5 Y 6/1); mica. Plant fragments present.
WM1394/1	Siltstone, yellowish grey (5 Y 7/2), wavy laminations. Plant fragments common. Pyritized plant fragments.
WM1415/3	Siltstone, light olive grey (5 Y 6/1) and pale yellowish brown (10 YR 6/2), laminated; carbonate; mica. Plant fragments present.
WM1456/5	Banded medium grey (N5) mudstone and yellowish grey (5 Y 7/2) siltstone; mica.
WM1537	Siltstone, greenish grey (5 GY 6/1), wavy laminations; mica.
WM1569	Mudstone, yellowish grey (5 Y 8/1); mica.
WM1610/6	Mudstone, light olive grey (5 Y 6/1); mica. Plant fragments common.
WM1645	Mudstone, light olive grey (5 Y 6/1); mica. Plant fragments common.
WM1655	Siltstone, banded very light grey (N8) and light grey (N7), wavy laminations; mica.
WM1681/6	Siltstone, pinkish grey (5 YR 8/1), laminated; mica. Plant fragments present.
WM1740/6	Siltstone, banded yellowish grey (5 Y 8/1) and medium light grey (N6); mica. Plant fragments present.
WM1749/8	Mudstone, banded light olive grey (5 Y 6/1) and very light grey (N7); mica. Plant fragments present. Ostracods abundant.
WM1757	Siltstone, yellowish grey (5 Y 8/1), wavy laminations; mica. Ferruginous staining, greyish orange (10 YR 7/4).
WM1795	Mudstone, medium light grey (N6), laminated; calcareous; mica. Plant fragments present. Ostracods abundant.
WM1819/5	Shale, banded light grey (N7) and medium grey (N5); mica.
WM1843	Siltstone, light olive grey (5 Y 6/1), wavy laminations; mica. Plant fragments common.

WORBARROW BAY

W111	Fine sandstone, light olive grey (5 Y 5/2), unsorted; semi-consolidated. Abundant plant fragments.
W9	Unsorted siltstone with larger pebbles, light brownish grey (5 YR 6/1). Abundant plant fragments.
W12B	Banded fine sandstone and siltstone, pale yellowish brown (10 YR 6/2); semi-consolidated. Plant fragments present.
W14	Mudstone, medium light grey (N6). Plant fragments abundant. Ostracods.
W2	Medium sandstone, light brownish grey (5 YR 6/1), unsorted. Plant fragments common.
W15	Medium sandstone, pale yellowish brown (10 YR 6/2), unsorted. Plant fragments common.
W121	Siltstone, dark yellowish brown (10 YR 4/2), unsorted. Large plant fragments abundant. Ferruginous stains, light brown (5 YR 5/6).
W18	Mudstone, medium light grey (N6). Plant fragments present.
W124	Banded siltstone, greyish olive (10 Y 4/2) and greyish yellow (5 Y 7/2), unsorted. Small plant fragments present. Ferruginous staining, dark yellowish orange (10 YR 6/6).
W128	Fine sandstone, dark greenish grey (5 GY 4/1), unsorted. Large plant fragments. Ferruginous stains.

[*Owing to Authors' revision there are no pages 602–606*]